A Iron Covering as a Protection Against Maguetization

by Joseph Barlow Lippincott

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A Graduation Thesis

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It has been found by those working around electrical apparatus where powerful magnets were used, and especially by those engaged in operating dynamos in connection with electric light plants, that their watches no longer kept good time, that they ran by fits and jerks if you may use the expression.

The effect was laid at the door of the electro-magnets, and experiments were inaugurated to counteract this effect.

After investigating the matter thoroughly Mr. W. A. Blish of Nyles Mich, a jeweler, claims to have solved the problem, by substituting an insulated soft iron case for the gold or silver one in use.

It is the purpose of this paper to test the accuracy of this theory.

It is readily seen that if two steel wheels of a watch

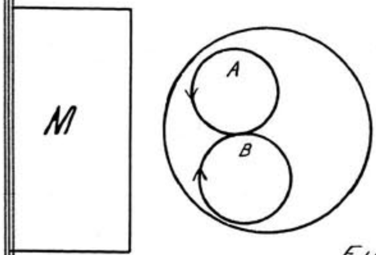


FIG. 1

A and B were brought into the magnetic field M, and if M were positive the two adjacent sides of the wheels would be negative. If the wheels revolved in the direction indicated the like poles in approaching each other would be retarded but as soon as they were diverging the motion would be accelerated. That is if the wheels are steel and are only temporarily in the field.

There would also be a marked effect produced upon the main spring, as shown in Fig. 2.

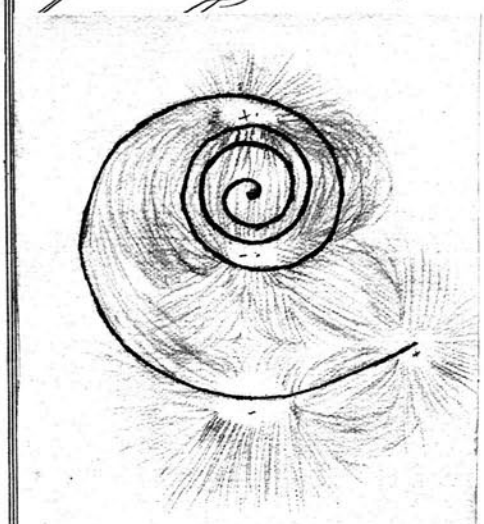


FIG. 2

Remembering that like poles repel and unlike attract ~~we~~ it would be very plain that the spring would not act normally.

Mr. Blish claims that by covering these works with an insulated soft iron case the magnetization will be prevented.

The following is a test of the theory.

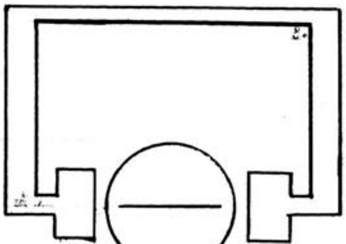


Fig 3

A soft iron box is placed between the poles of a strong electro-magnet. A piece of hardened piano wire is insulated and placed in the box. The current is kept constant by means of a resistance box and galvanometer. The time in each case is the same. The needle is then removed and suspended in a Coulombs ballance and the number of vibrations per minute noted. The number of vibrations being proportional nearly to the intensity of the magnet

Galvanometer 103°

Time 10'

1	34.5	vibrations	per	30"	with	great	amplitude
2	33.5	"	"	30"	"	"	"
3	32.0	"	"	30"	"	"	"
4	34.0	"	"	30"	"	"	"
5	33.0	"	"	30"	"	"	"
6	33.0	"	"	30"	"	"	"
7	32.5	"	"	30"	"	"	"

giving an average of 33.21 per 30"
or 66.42 per 1' with great amplitude

With small amplitude the result is somewhat different

1 37.0 vibrations with small am. in 30"
2 36.0 " " " " " "
3 35.0 " " " " " "
4 38.0 " " " " " "
5 37.0 " " " " " "
6 37.0 " " " " " "
7 37.5 " " " " " "
8 37.5 " " " " " "

295.0 ÷ 8 = 36.87 per 30" or 73.74 per 1'

Great amplitude 66.42
Small " 73.74
Average 140.16 ÷ 2 = <u>70.08</u> per 1'

The soft iron box is touching the pole in these experiments.

The box is of thin sheet iron.

Next we place a needle of like temper in the glass tube and then place the tube between the poles of the magnet. There is no neutralizing force now at work.

Conditions same as before
Galvanometer reading 104°
Time 10'

1 35.6 vibrations per 30"
2 36.4 " " "
3 36.5 " " "
4 36.0 " " "
5 36.0 " " "
180.5 ÷ 5 = 36.1 × 2 = 72.2 vibrations per 1'
Number of vibrations per 1' in tube 72.20
" " " " " " iron box 70.08
Difference 2.12
or a loss of 2.12 % of magnetic force.

The small effect produced is most likely due to two causes either from the fact that the box ~~touches~~ the poles of the magnet or from the thinness of the box.

The case is again tested in the same manner. The current being weaker

Galvanometer 54.°
Time 10'
26 vibrations per 30"
26 " " "
26 " " "
78 ÷ 3 = 26 × 2 = 52 vibrations per 1'. This is in the thin iron box
In the glass tube
Galvanometer 54. Time 10

1 34.0 vibrations per 30"
2 35.0 " " "
3 35.0 " " "
104.0 ÷ 3 = 34.66 × 2 = 79.32 vibrations per 1'
The exposed needle gives 64.9
In the thin iron box 52.0
Difference 12.9 a loss
by neutralization of 19.88%
The case is again tested
In the thick iron box
Galvanometer 54°. Time 10'. Care being taken not to heat the needle in sealing the tube.
1 29 vibrations per 30"
2 30 " " "
3 30 " " "
89 ÷ 3 = 29.66 × 2 = 59.32 average per 1'
To show the effect upon the needle by reducing the current, let the galvanometer read 51°, the other circumstances being same as before and we have
1 27.5 vibrations per 30"
2 28.0 " " "
3 27.7 " " " average 55.56 per
4 29.7 " " "
5 26.0 " " "

We find the intensity of the needle proportional to the ~~###~~ strenght of the current.

In glass tube.

Galvanometer 51°. Time 10'

1 69.4 vibrations per 30"

2 71.4 " " "

3 72.2 " " "

4 74.4 " " "

5 76.0 " " "

Average 73.7 per 1'

In glasstube 73.7

In this iron box 55.5

Loss 18.20 = 24.55 %

In all of these experiments the tin box has been touching the poles.

Next the experments are made in an iron box made of gas piping. The box being thicker than the one previously used.

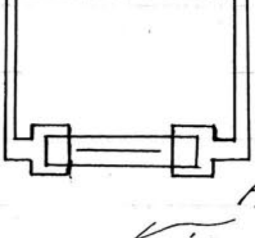


FIG 4

The iron box is too long to lay between the two poles of the magnet and therefore is not in the strongest field

Time and galvonometer constant.

1 19.5 vibrations per 30"
2 18.5 " " "
3 20.0 " " "
4 18.0 " " "
5 17.0 " " "
6 18.0 " " "

Gives an average of 37.0 per 1'

Conditions same as above with the unprotected needle save now the needle lays in the strongest magnetic field cutting the greatest number of lines of magnetic force possible.

1 31 vibrations per 30"
2 33 " " 30"
3 32 " " 30"

Average 64.0 vibrations per 1'

In this experiment the iron box (gas pipe) is shorter and goes between the poles ~~tou~~ touching one.

1 29 vibrations per 30"
2 31 " " 30"
3 30.5 " " 30" Average 61.14 per 1
4 30.5 " " 30"
5 31.5 " " 30"
6 30.5 " " 30"
7 31.0 " " 30"

In glass tube under same conditions

1 38. vibrations per 30'

2 38. " " "

3 35. " " "

4 36. " " "

5 35.5 " " "

Average 72.0 vibrations per 1'

Unprotected 72.00

In box 61.14

Loss 10.86 = 13.69%

In the gas pipe box.

In this case care is taken that the needle does not touch the pole

Galvonometer 233°. Time 10'

Needle is placed in the strongest field but shows no signs of magnetization, either in the ballance or with iron filings.

In the thin iron box. Conditions the same. Distant 2. c.m. from the pole. Gives but slight signs of magnetization.

The following experiments are made with telescope graduated scale and mirror galvonomiter. The results much more accurate.

The deflection is about proportional to the intensity of the magnet

The natural reading averages 46.23.

The steel wire is insulated as before and placed in the gas pipe box in the strongest field, care being taken to keep the poles from touching the box,

Time 5"

1 Deflection 45.6

2 " 46.5

Average 46.05 showing a deflection from the zero point of .12 c.m.

Conditions the same with naked wire

1 Reading 30.9

2 " 33.4

3 " 29.4

Average 31.4

Showing a deflection of 14.83 from the zero point. It is seen that the protected magnet is weaker by 99.88%

When the iron box touches the pole

there is a reading 57.0 or 10.77 c.m from the natural. The protected magnet is 72.63% less strong than the unprotected after being subjected to the same conditions

Owing to changed position of the galvanometer the average zero point is now <u>43.7</u>

The same conditions of strength of current time etc. In iron box not touching pole

1 Reading 43.7

2 " 43.7

3 " 44.6

Average 44.0 a deflection of but .3 c.m. from zero point, = 00.20% of deflection of unprotected needle

The iron box has itself become magnetised but produces no apparent effect upon the needle,

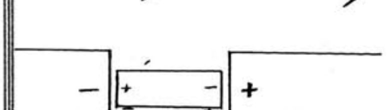


Fig 5

If the needle is placed outside the box but quite near it, we would have the plus pole directly influencing the needle in a negative way and indirectly through the box in a positive way. These forces would tend to neutralize each other as shown in the result.

Needle as in Fig. gives a deflection 7.2, unprotected it gives 14.8.

From this we see that one half the intensity is lost on account of the box.

We may conclude then that as long as the watch is not allowed to ~~tarch~~ touch the poles of the magnet that a soft iron case largely, if not altogether, protects it. A thick case or covering seeming to give the best results.

This result may be explained in two ways either one of which may be right or both may work together to produce the result.

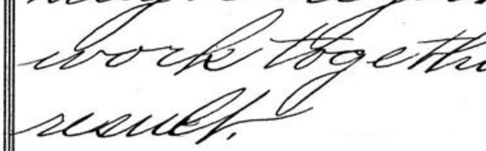
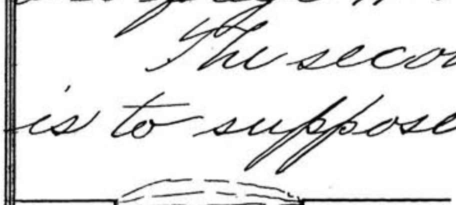


FIG 6

The plus pole of the magnet by direct induction tends to make the needle minus in its adjacent end, and indirectly throuthe iron box covering it tends to make it plus. Thus we will have two magnetic forces in opposition to each other working on the needle. These forces neutralize each other the stronger predominating.

The intensity of a magnet is inversely proportional to its distance (or practically so). Thus we would have the direct induction represented by $\frac{1}{AC^2}$, and the indirect by $\frac{1}{(AB+BC)^2}$, giving the greatest effect indirectly. This would be quite small and perhaps would account for the slight magnetism of the needle. See also page 11 Fig 5

The second way of explaining is to suppose the iron case a



better conductor of magnetism than air, and that all the lines of magnetic force will follow the iron covering and not shoot across the vacant space inside, thus leaving that space free from the lines of magnetic force, therefore the needle does not become magnetized.

Between the two theories I would prefer the latter.